Pacific Science (1998), vol. 52, no. 4: 276–286

Tropical Biology and Research Institutions in South and Southeast Asia since 1500: Botanic Gardens and Scientific Organizations to 1870[1]

DAVID G. FRODIN[2]

ABSTRACT: Tropical biological stations have become in the last half-century a well-established phenomenon. They are, however, but a modern manifestation of a long tradition of institutionalized study of tropical biological diversity, an approach gradually adopted by Europeans as one response to the needs and challenges of a new environment. This paper describes the growth of early institutions in South and Southeast Asia (and Mauritius), particularly botanic gardens, learned societies, and scientific surveys, and examines their relative successes and failures in relation to their geographical and political circumstances. The interaction among the Dutch, French, and British spheres is examined in relation to the appearance of new ideas. It is concluded that although all these powers were from time to time innovative, the British and Dutch, though in different ways, became the most successful in their lasting influence on pure and applied tropical science. The British network, internally strong and effectively worldwide by the nineteenth century, was notable for its breadth but featured less autonomy for individual units; the Dutch, fortunately situated in Indonesia and heir to an autonomous biological tradition, established in Bogor the beginnings of what became after 1870 a major biological (and, indeed, academic) center.

TROPICAL BIOLOGY IS now fashionable. Tropical biological stations have become numerous, not least in the Americas (Castner 1990), reflecting the growth of interest in tropical field biology since World War II. This has been associated with revolutions in transportation and technology, and changes in approaches to the study of organismal biology. However, these stations also represent a realization of calls, beginning in the 1930s, for more on-site research by writers such as Worthington (1938), Symington (1943), Honig and Verdoorn (1945), Verdoorn (1945), Corner (1946), and Richards (1952). These writers were influenced by leading late nineteenth- and early twentieth-century workers, such as Solms-Laubach (1884), Haberlandt (1893, 1910, 1926), Massart (1895, 1896, and in Honig and Verdoorn 1945:231–240), Willis (1901), Hill (1915), Trelease and McLean (1919), Hill et al. (1925), and Treub (in Dammerman 1945:59).

These scientists enjoyed tropical sojourns ranging from a few months to many years or even, like Melchior Treub, an entire career. As Holttum (1970) noted, many themes in tropical biology are founded upon their activities. Some, including Joseph Banks, Fritz Junghuhn, Heinrich Zollinger, Alfred Russel Wallace, Julien Harmand, and Alfred B. Meyer and, in the first half of the twentieth century, Lajos Biró, Evelyn Cheeseman, Lilian S. Gibbs, Ernst Mayr, and Paul Richards, carried out work on their own or as members of oceanic or inland expeditions. Others, increasingly after the middle of the nineteenth century, were formally attached to local research institutions.

Although the Amazon may symbolize the wonders of tropical life, it was in South and Southeast Asia that the study of tropical biology in a modern sense really began (Poivre 1771 [see Grove 1995:215]). This paper traces the origin, development, and

[1] Manuscript accepted 15 January 1998.
[2] Royal Botanic Gardens, Kew, United Kingdom.

progress of biological centers from the sixteenth to the mid-twentieth century, and the reasons for the ascendancy of a few to international prominence.

ORIGINS OF MODERN BOTANICAL GARDENS

European biological studies in South and Southeast Asia were for 250 years from the beginning of the sixteenth century largely concerned with the identification, exploitation, and transport of crops and other natural products of high market value. These included, among others, spices, plumes, seashells, wood and wood products, rattan, sugar, stimulants, and medicines. In South and Southeast Asia, these were most often handled through the factories or trading stations of chartered companies or related agencies operating with the support of metropolitan governments. Attached to many factories or official residences, especially those of the Dutch, were gardens where new or interesting plants were grown and observed. Their curators were usually medically qualified company or government officials.

These stations, as well as voyages of exploration, added greatly to Western knowledge of tropical Asian plants and animals, but the information was often haphazardly documented, with an emphasis on curiosities. The earliest important botanical work, based upon observations in his garden near Goa, was *Coloquios dos simples* by the Portuguese Garcia da Orta (1563; revised in 1567 with subsequent reissues and translations to 1605). The 1567 edition, in Latin, was by the Flemish botanist and traveler Charles de l'Écluse (Carolus Clusius), a man of unusual insight and contacts (de Wit 1949:lxxvii, Grove 1995:77). Publication of this, as well as l'Écluse's own works (notably *Rariorum plantarum historia* [1601] and *Exoticarum libri decem* [1605], the latter incorporating a final version of Garcia da Orta's work), through the renowned Antwerp firm of Plantin-Moretus ensured a wide circulation. These, together with l'Écluse's foundation directorship of the Leiden Botanic Garden from 1590 and, soon after, his professorship at Leiden University, surely stimulated the nascent Dutch commercial and scientific interest in the Asian tropics. As the Dutch interest developed and Dutch residencies were established in India from late in the sixteenth century onward, the work of Garcia da Orta and l'Écluse was further advanced by Jan Huygen van Linschoten, the first Dutch resident in Goa and Cochin (1583–1589), and, later, by Jacob Bondt (Bontius), resident in Jakarta (Batavia) from 1627 until his death in 1631 as physician to Governor Jan Pieterszoon Coen.

In the decades to come, the United East India Company, chartered in 1602, was favorable to the study of natural history over and beyond commercial needs. This reflected a concern on the part of the recently formed Dutch state for "careful observation and management ... of the natural world" (Grove 1995:127). Botanically this was recognized through a charter directive calling for attention to all kinds of plants, not merely the tradeable ones (de Wit 1949:lxxvi). The Company itself maintained gardens; that in Cape Town was described by Karsten (1951). With support from the universities, particularly in Leiden and Amsterdam (where a botanical garden was founded in 1682), the Dutch were able to lay a foundation for scholarly knowledge of the natural world of tropical Asia. Jacob Bondt's six-part work on medicinal and other plants appeared in 1658 as *Historiae naturalis et medicae Indiae orientalis libri sex*, and over the next decades, resident Company officials prepared systematic botanical and zoological works of fundamental importance. These included Paul Hermann, a physician in Ceylon in the 1670s; Hendrik van Rheede, with three terms (1663–1667, 1670–1677, 1685–1691) in Malabar (now in the modern Indian state of Kerala); and especially George Rumpf (Rumphius), ultimately "first merchant" (administrator) in Ambon (Moluccas) for almost 50 years from 1653. Rheede also set up at Cochin a "laboratory" for pharmaceutical manufacture, and Hermann was, after his Company service, professor of botany and director of the botanical garden at Leiden University (1680–1695).

Other scholars in Company service included the Germans Andries Cleyer and Engelbert Kaempfer. Cleyer, a correspondent of Rumphius, was Company pharmacist and garden designer in Batavia for over 20 years from 1666 (with two terms in the Company's Japanese factory in Deshima off Nagasaki in the 1680s) and was the probable sponsor of *Der orientalisch-indianische Kunst- und Lust-Gärtner* (1692) by his gardener, Georg Meister. Kaempfer, a physician, is most noted for his work in Japan, where he spent 2 years (1690–1691) in Company service and later wrote *Beschrijving van Japan* (1729), published after his death. In Amsterdam, those actively interested in Asian natural history included Jan and Caspar Commelijn, Maarten Huydecoper van Maarseveen (also a director of the Company), and, later, Johannes and his son Nicholas Burman were active. The elder Burman edited and saw Rumphius' *Herbarium amboinense* through the press (1741–1750), and Nicholas, employing the binomial nomenclature of Linnaeus, synthesized knowledge of the tropical Asian flora in *Flora indica* (1768). All these works, particularly Rheede's *Hortus indicus malabaricus* (1678–1703), edited for publication by Arnold Syen (in Leiden) and Jan Commelijn, made their mark upon European awareness of tropical forests and environments (Grove 1995).

However, in spite of the publication of Rumphius' and the younger Burman's works, the mid- and late eighteenth century witnessed a gradual decline of direct Dutch interest in natural history. When the Company faced increasing competition, it became less interested in new initiatives. In Java, however, increasing security laid the groundwork for future advances. Private estate gardens for wealthy and well-connected Company officials and others made their appearance around Batavia, and in the capital the Company in 1744 under Governor-General Baron Gustaaf von Imhoff reserved a large piece of land at Buitenzorg (Bogor), 53 km to the south, as gardens and grounds for their governor's country residence. A "hortus medicus" existed for a time in the 1760s (Bastin 1990:9). Yet there were few significant developments save for the formation of the Bataviaasche Genootschap and visiting scientists and expeditions. Beyond the Dutch sphere, there was little organized activity in Southeast Asia until the nineteenth century. A Spanish garden at Manila and the visit to the Philippines in 1792 by the Malaspina voyage of circumnavigation left no lasting developments; indeed, after 1815 and until the mid-nineteenth century, those islands were isolated from the main currents of European botany.

Eventually, an increasing economic interest in sugarcane, tobacco, coffee, and other plantation crops, along with food staples such as manioc (*Manihot utilissima*) and breadfruit (*Artocarpus altilis*), stimulated scientific inquiry. Tree crops, among them mulberry (*Morus alba*) for silkworms, blackwood (*Albizia lebbek*), nutmeg (*Myristica fragrans*), and teak (*Tectona grandis*), were also grown (Grove 1995:169). In the second half of the eighteenth century, however, botanical gardens were also conceived as having amenity value. In tropical Asia, the first relatively spacious establishments were created by the French Compagnie des Indes in Mauritius (Île de France). The first came into being in 1735 under Governor Mahé de Labourdonnais (founder of the island's sugar industry) at Pamplemousses near Port-Louis. Labourdonnais focused upon food crops and other useful plants, including the mulberry; it was through this garden that manioc reached Asia. Another garden was created in 1746 at Le Réduit under Labourdonnais' successor, Pierre David, with, from 1753, the aid of the later Guiana explorer Jean-Baptiste Fusée Aublet. The Crown assumed control of the island in 1764, and from 1767 the Pamplemousses garden under Comissioner-Intendant Pierre Poivre acquired permanancy. There, Poivre successfully introduced the key species of spice trees, thus breaking the Dutch monopoly. In a related development, the functions of Aublet were partly assumed by Poivre's appointments of Philibert Commerson, a "missionary-naturalist" (in his own words [Grove 1995:240]) recruited in

1768 from Bougainville's expedition, and, as Commerson's assistant, his nephew Pierre Sonnerat. Although in its time short-lived (Poivre returned to France in 1772 and Commerson died in 1773), the Pamplemousses garden realized for the first time in the Tropics the now-established institutional association of garden and scientists. Pamplemousses' development of ornamental horticulture began in 1772 under Jean Nicolas de Céré, a protégé of Poivre; in 1775, Céré became director and remained so for 35 years.

All this was contemporary with developments at the Royal Botanic Gardens, Kew, where initially Lord Bute and then, from 1772, Sir Joseph Banks were scientific advisers, and later in Bengal. In 1786 concerns similar to those of the French in Mauritius, along with knowledge of the work of Labourdonnais, caused Captain of Engineers and Military Secretary to the Bengal Government Robert Kyd to recommend establishment of a botanical garden at Calcutta, then developing into a major city. The British East India Company sought advice from Banks (Biswas 1950, Carter 1988), who had seen reports of the Pamplemousses garden and was familiar with the work of Aublet, Poivre, and Commerson. Moreover, he eventually bought Aublet's herbarium (Desmond 1992, Grove 1995). He was also conversant with the work of a recently established and successful trial garden in St. Vincent in the West Indies.

The Calcutta garden accordingly was established in 1787 at Sibpur outside Calcutta on the right bank of the Hooghly, where it remains to the present day. Although Banks took the view that scientific and agronomic studies should be foremost, Kyd was not insensitive to the needs of a growing metropolis and had also advocated the garden as an amenity. Under Kyd's successor, William Roxburgh (1793–1814), these roles were combined successfully and Sibpur became an attractive recreational resort as well as a center for botanical research, horticulture, and crop and tree trials. At the same time, it became a key center for the system of international plant exchange developed by Banks from Poivre's model (Grove 1995:339). This modified Banksian "utility with beauty" model subsequently was implemented elsewhere in tropical Asia, beginning with Prince of Wales Island (Penang) in 1800, in line with the expansion of primary industry and forestry, with amenity of increasing importance.

THE ROLE OF LEARNED SOCIETIES

Concomitant with the development in Asia of botanical gardens on a larger scale was the rise of the learned society. An academy of higher learning was proposed in Mauritius (Monnier et al. 1993) around 1770, and a society came into being in 1801, with the present Society of Arts and Sciences established under British auspices in 1811 (Grove 1995). However, the learned society, a seventeenth-century product of the Enlightenment (Ornstein 1938), first acquired an Asian complexion in Batavia and Calcutta. That in Batavia, the Bataviaasche Genootschap van Kunsten en Wetenschappen, was founded in 1778 by a well-placed Dutch Company official, Jacob Radermacher, in association with Frederik, Baron von Wurmb, and others. In Calcutta, the arrival of the polymath William Jones in 1783 as a judge in the Supreme Court provided the catalyst for the formation of the Asiatic Society early in the following year (Desmond 1992). Both societies acquired houses, established journals (the *Verhandelingen* from 1779 and *Asiatick Researches* from 1788), and accumulated collections, although in a tropical or subtropical climate before the advent of air-conditioning the preservation of biological specimens was problematic (cf. Wallace 1869). Both societies also served as advocates for the natural sciences in the initial years of their professionalization and helped to bring about their official acceptance and support, although, as already indicated, social and political factors delayed this development in the Dutch possessions. They were regularly consulted by governments and enjoyed official support.

The Asiatic Society, well supported from

the start, was until his death in 1794 presided over by Jones, who drew attention to the importance of a proper investigation of the Indian flora and its resources, as well as of local agricultural practice. He created the climate in which proposals such as Kyd's could find a hearing (Desmond 1992:57). The Batavian Society was in its early years less influential. Its prime movers, Radermacher and von Wurmb, died, respectively, in 1783 and 1781, and save for the work of Francisco Noroña (Noronha) in 1786–1787 little was accomplished until 1801. A renewed interest in plant introduction on the part of the Dutch Company was expressed only in 1795; in that year, however, the French took effective control of the Netherlands, and in 1798 the Company itself was dissolved.

Continued growth and influence in Calcutta and renewal in Batavia characterized the early nineteenth century. The Asiatic Society in Calcutta acquired a permanent home in 1808 and in 1817 established a museum encompassing archeology, geology, and zoology. In this respect, it took a path pursued by learned societies elsewhere. Official recognition of the importance of its collections resulted in government assistance from 1841. The Society also advocated official surveys, including the Survey of Bengal instigated by Governor-General Lord Minto in 1807. In Java, the Batavian Society experienced a modest revival following the settlement in 1801 of the American naturalist Thomas Horsfield as a military medical officer. In 1803, this Society was able to persuade the Dutch authorities to support Horsfield's work in botanical exploration and materia medica (Bastin 1990:9–10). A more marked renewal followed the advent of British rule in the Dutch possessions and the arrival of Stamford Raffles (Bastin 1990:46). In 1814, the Society was granted use of part of the newly completed social club Harmonie. Throughout his time in Java, Horsfield regularly reported on his travels and surveys, which by his departure in 1818 had become the most extensive essayed there. In 1812, his work was officially acknowledged by Lord Minto (Bastin 1990:41).

Thus, by 1816 development of the sciences in both Bengal and Java could be regarded as more or less comparable. As de Wit has written, "the English interregnum in Java ... in addition to promoting the natural sciences, had made the Dutch realize that the time-honoured tradition of ranking among the foremost botanists in tropical Asia had been taken from their hands" (de Wit 1949:cviii). The Dutch reaction to British rule was immediate. Their perceived leadership in East Indian science was seen as threatened. Under the stimulus of King Willem I, his general secretary Falck, and the first Governor-General, Baron van der Capellen, the new Indies government returned with specific instructions to develop the pure and applied sciences. Caspar G. C. Reinwardt was appointed to prosecute this task as director for agriculture, the arts, and sciences. In 1817 the 's Lands Plantentuin (Hortus Bogoriensis) was established at Buitenzorg (Bogor) on Reinwardt's initiative, and in 1820 a Natuurkundige Commissie was organized in the Netherlands. Other scientific units followed in the decades to 1850.

This not unnaturally had an effect on the Batavian Society. Although the members continued to promote and publish papers in their *Verhandelingen*, support was building for a separate scientific society. In 1850 this came into being as the Natuurkundige Vereeniging (Koninklijke from 1860), and the Batavian Society withdrew from the natural sciences (but retained its arts and ethnographic collections, now the basis of the Muzium Pusat in central Jakarta). Institutional development in India was slower, with significant developments not taking place until after 1850. The Asiatic Society thus provided one of the few regional sites for zoological studies until establishment of the Indian Museum in Calcutta in 1866. This museum, first advocated by the Society in 1856, then took over all their remaining collections, apart from geological specimens, which went to the Geological Survey (established in 1850). Although their *Journal* continued to publish scientific papers for several more decades, the Society, like its Batavian counterpart, from then increasingly focused on the humanities.

BOTANICAL GARDENS AND OTHER INSTITUTIONS AFTER 1800

Botanical Gardens

The success of the East India Company garden near Calcutta inspired the formation of gardens elsewhere. The first was a short-lived undertaking at Penang (Prince of Wales Island), the first of the British "Straits Settlements," founded under William Roxburgh, superintendent in Calcutta, in 1800, primarily as a spice garden. This was discontinued in 1805. A second, formerly native royal garden at Bangalore in southern India was acquired in 1803, but returned to the local ruler in 1810 (Desmond 1992:106). In 1819, a proposal by George Govan to convert a former pleasure garden at Saharanpur north of Delhi into a botanical garden specializing in subtropical and temperate crops and other plants was approved by the Company; this remains in use today as a horticultural station (Desmond 1992:112). In 1822, a second Penang garden came into being under Nathaniel Wallich, Roxburgh's successor as superintendent at Calcutta, and in the same year a first garden was founded in Singapore.

In both Penang and Singapore, Wallich had had the backing of Raffles, but following the latter's final recall continuing support was not forthcoming and the gardens were accordingly closed, in 1826 and 1829, respectively. The current Botanic Gardens in Singapore were founded under private auspices in 1859, becoming a government institution in 1875, and the Waterfall Gardens in Penang were established in 1884. The foundation of 's Lands Plantentuin in Bogor (the present-day Kebun Raya Indonesia) has already been mentioned; and in 1821, botanical activities in present-day Sri Lanka were under Alexander Moon moved from the old, small Dutch garden in Colombo to the current spacious site in Peradeniya near Kandy. Development of Pamplemousses in Mauritius continued; during the nineteenth century it became primarily a "pleasure" garden and is still world-renowned (Owadally 1988).

Of these gardens, those at Bogor, Peradeniya, Singapore, and Calcutta have furnished lasting contributions to pure and applied science (Holtum 1970). All were comfortably situated in secure environments that facilitated research. By contrast, proposals for a second botanic garden in Manila were not realized until 1858 and on an unsatisfactory site, and the French foundations in Saigon (1865) and, later, Hanoi did not continue as scientific establishments. The first botanic garden in China was established in Hong Kong under British rule only in the late nineteenth century; plans in 1888 by the first administrator of the colony of British New Guinea, William MacGregor, for a similar establishment in Port Moresby never came to fruition, substantially delaying local scientific development (Frodin 1990). The realization that New Guinea was itself a center of crop diversity with an independent agricultural history came only well into the twentieth century (Diamond 1997:98–100, 303).

Until the advent of zoological museums, marine stations, and higher scientific schools (all developments from after 1870), the successful botanical gardens were the only institutional centers in tropical Asia for biological studies, inevitably more botanical than zoological. Extensive collections of living material, notably in Bogor, were built up; preserved specimens and samples were accumulated as local interest in identification, classification, and description of the flora developed. Results were published in the journals of local learned societies, and as communications improved, their reputation was spread by scientific travelers, some (particularly after 1850) with academic connections.

It was 's Lands Plantentuin at Bogor that came to enjoy the closest academic links, and through them contacts with "general" as opposed to systematic botany (Went and Went 1945). Its founder, Reinwardt, had early in his career held a chair at the former university of Harderwijk in the Netherlands (Sirks 1915); in 1822, he was appointed to a professorship at Leiden University. His successor, Carl Blume, enhanced its scientific reputation through his *Catalogus* (1823) and *Bijdragen tot de flora van Nederlandsche Indië* (1825–1826) before returning to Europe in

1826. They were aided by two Kew-trained gardeners, W. Kent and J. Hooper, and the garden was developed as an amenity as well as for trials and organized collections (trials were moved to a separate, nearby site in 1876). Although without a director for over 40 years after 1826 (beginning with the financial stringency resulting from the Java Wars and largely coinciding with the era of the Kultuurstelsel) and for most of that time subordinated to the Palace guard, development continued, particularly from 1831 under Hooper's successor, Johannes Teysmann. Teysmann, curator until 1869 (the two final years under a restored directorate), greatly enriched the living collections; under him were established a library (1842), a herbarium (1844), and the Cibodas mountain garden (1864). In these projects and others, he was aided by Justus Hasskarl (1838–1843, 1845–1846), Simon Binnendijk (from 1850), and Sulpiz Kurz (about 1859–1864).

In the late 1850s Willem de Vriese, Reinwardt's successor at Leiden, visited the Gardens and other parts of current-day Indonesia, mostly in company with Teysmann; this would prove valuable for the future following the return of more "liberal" tendencies in the Netherlands. By contrast, the Banks-inspired "Kew system" with which Pamplemousses, Sibpur, Peradeniya, and Singapore were associated was relatively self-contained, with few if any academic links; because of size and geographical extent the Kew system was arguably "self-sustaining." With the growth of more specialized professionalisms in the latter part of the century, the "Kew system" would in part be found wanting; in particular, the first inspector-general of the Indian Forest Service, organized in 1864, was Dietrich Brandis, a German with no prior connections to the "Kew circle."

The Natuurkundige Commissie in the Dutch Indies (1820–1850)

Reinwardt had set up 's Lands Plantentuin on his own initiative as part of his overall program for agricultural and scientific development of the Dutch territories. It did not, however, have a mission over the natural sciences in general, nor could its director focus entirely on observation and collecting during his official tours. In April of 1820, accordingly, a separate but relatively inclusive Natuurkundige Commissie (Natural Sciences Commission) was organized in the Netherlands under the particular initiative of C. J. Temminck, a zoological contemporary of Reinwardt and first director of the present Rijksmuseum voor Natuurlijke Historie in Leiden. Large parts of the East Indies remained poorly described; moreover, Horsfield had taken all his collections to England, so that little material was available to Dutch scientists.

The remit of the Commission was to carry out topographical, geological, and biological surveys of the Dutch Indian possessions. Altogether, 13 members and several artists and technical staff were employed over the 30-year life of the Commission. Five people were on average in post at any one time, either in Indonesia or in Europe. But, of the full members, nine died in the field. Although most died from disease (one was murdered in the Chinese rebellion of 1832), a contributing factor was "stress," with its inevitable strain on one's immune system. Entering the Tropics, young men worked themselves to exhaustion, thus never fulfilling their early promise. The most poignant of these were Heinrich Kuhl and Johan van Hasselt, friends who departed for Java at the end of 1820, but who died in 1821 and 1823, respectively; they share a common grave in the Kebun Raya.

With the support of Reinwardt, Blume, and Temminck, the Commission persevered in spite of its losses in men and material. Successive members toured Java, Sumatra (1827 and 1833–1835), the Moluccas, Timor and New Guinea (1828–1829), Borneo (1836–1837 and again in the 1840s), and north Sulawesi and the Moluccas (1840–1843). Their collections formed the basis for Temminck's Rijksmuseum as well as the core of 's Rijks Herbarium, established in 1829 in Brussels under Blume's direction, but removed to Leiden at the outset of the Belgian rebellion of 1830. All the collections, with their numerous primary types, remain of

great importance to the study of Malesian biodiversity. In addition, some scientific direction was given to 's Lands Plantentuin, including formation of a systematic arrangement for the living collections, still one of its important features (de Wit 1949:cxi).

Nevertheless, the losses and apparent paucity of results resulted in a review by the Indies Governor-General in 1836. Over the previous decade, the Dutch had suffered reverses, including the Java War of 1825–1830, the failure of a settlement in New Guinea, the secession of Belgium in 1830, and the Chinese rebellion in Java in 1832. Under Governors-General Du Bus (successor to van der Capellen in 1826 and an architect of the Kultuurstelsel) and Merkus, a more conservative political climate ensued, reflecting metropolitan trends, that lasted until the 1860s. Two Commission members, the botanist Pieter W. Korthals and the zoologist Salomon Müller, were seconded to Europe to help Temminck work up the accumulated collections. The major result was the 3-volume *Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche Overzeesche Bezittingen* (1839–1847) edited by Temminck. Its first volume, by Müller, contains his first ideas on Malesian zoogeography, a forerunner of those of Wallace and later more fully developed in German (1846). It was, however, far from comprehensive in its coverage; in botany, Korthals preferred detailed studies with the result that relatively few plant families were published.

The 1840s were, as elsewhere, a time of increasing specialization. This was turned to good effect by the geologist C. A. L. M. Schwaner in Borneo, in his posthumously published book, *Borneo* (1853), and by the polymath Frans Junghuhn, the "Humboldt of Java" (Sirks 1915), who explored the island in the 1830s and 1840s and later wrote a definitive four-volume topographical, *Java, zijne gedaante, zijn plantentooi en inwendige bouw* (1853–1854). But these came too late to save the Commission, which was terminated in April 1850. The low level of results had surely taken its toll; in addition, Junghuhn was inclined toward a single-minded independence (de Wit 1949). An integrated approach to topographical and biological survey in the Dutch East Indies would not return until after 1870. In the intervening 20 years, organized Dutch scientific work was at a relatively low ebb and as much, if not more, work was done by outsiders. These included French, British, and United States world voyages through 1842 and, most famously, Alfred Russel Wallace between 1854 and 1862.

The great tropical biological centers of Asia of the late nineteenth and early twentieth centuries were largely based on botanical gardens established over the previous century or more by various European powers with an economic and later also a direct and indirect social interest in plants, plant products, and forests. The gardens in turn reflected observations and small-scale trials made in the sixteenth and seventeenth centuries. The effective participation and lasting reputation of the different powers in tropical Asian pure and applied biology in this formative era are more or less directly related to their maritime history, as well as to their level of botanical awareness and corresponding interest in documentation. Both these factors strongly favored the Dutch in the seventeenth and eighteenth centuries, enabling them to obtain a position of botanical leadership in which they took some pride. Local establishments, however, remained small and inland exploration generally limited. An increasing interest in bulkier plantation crops, such as cane sugar, prompted an interest in larger trial grounds, for which the French, in control of Mauritius from 1722, were well placed. Suitable land was first developed in 1735, and under Pierre Poivre from 1767 to 1772 there came into being the first known association of domain, grower, and scientist. Poivre's domain also became under his successor Nicolas Céré the first "pleasure garden" in the Asian maritime world, a reflection of developing local as well as metropolitan sensibilities toward the environment (Grove 1995). It was thus comparable with European establishments such as in Paris or at Kew near London, then also recently founded. This "new garden idea" made its way into British

territory at Calcutta in 1786–1787, thence through other parts of South and Southeast Asia; topographically the best sites were Buitenzorg (Bogor) (1817), Peradeniya (1821), and Singapore (1859).

These gardens did not necessarily achieve a Poivre establishment model from the beginning. Sustainability in the form of official institutionalization of practical and intellectual resources developed slowly though not necessarily behind similar developments in the metropolitan sphere. Again, government policies and personalities played a key role. In Indonesia, the state, relatively autonomous, was always Java-centric and this served to concentrate resources. In pure and applied biology and natural history Bogor thus became a natural center in spite of early difficulties. Links with metropolitan universities were established at the same time, which boded well for the future.

Establishments in British territories all became part of the world-wide "Kew system" (Brockway 1979, McCracken 1997). Although this could draw upon a wide range of expertise, much of it in fact Scottish, it had relatively few university connections. The Calcutta garden, in terms of resources the most nearly comparable with Bogor, was not well placed for some kinds of trials, but being close to the Himalayas and other relatively temperate areas, it played an important role in horticulture. However, although of great importance as a city amenity and close to a learned society, its location was less salubrious than that of Bogor; thus in time it failed to attract associated institutions, including specialized educational establishments (although its staff were long involved in local college teaching). Zoological studies were slow to develop, because of the difficulties of preservation of specimens and, until after the mid-nineteenth century, a lesser role in the colonial economic and social environment. Early local progress centered mainly on the learned societies and, in Indonesia, the Natuurkundige Commissie; much, however, continued to be done by outsiders. Although Commission member Müller effectively established zoogeography in Malesia, it was the independent traveler Wallace, writing in English for both scientific and popular audiences, who brought lasting fame to the region's animal and insect life. However, although Wallace's work was largely extra-institutional, the future largely would lie in new or renewed institutions.

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